BUSINESS-CYCLE ASYMMETRY AND CAUSALITY BETWEEN FOREIGN DIRECT INVESTMENT AND FIXED CAPITAL FORMATION

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Abstract
This study creates the threshold vector autoregression model and employs quarterly data of Taiwan from 1981 to 2006 to examine the relationship between foreign direct investment (FDI) and domestic gross direct investment (GDI). Our framework provides a consideration of business cycle asymmetry that quite differs from the existing approach. We find that (1) the long-run relationship between FDI and GDI is complementary; (2) the relationship between FDI and GDI is substitutive during expansion, however, is complementary during recession; (3) a depreciation of the Taiwanese Dollar helps attract FDI during expansion, but decrease GDI during recession; (4) the negative impact of Taiwan's outward foreign direct investment and national saving on GDI, the negative impact of GDP on GDI and the negative impact of Taiwan's outward investment on FDI are only evident during recession; and (5) macroeconomic variables indirectly affect FDI during expansion and GDI during recession through the adjusting process toward equilibrium.

Keywords: foreign direct investment, gross direct investment, current depth of recession, Threshold model

JEL Classification: C10, F20, F40

Introduction

FDI plays a very important role in fueling economic growth. One of the ways of looking at the important of FDI inflows in an economy is to express them as a percentage of gross fixed capital formation. Gross fixed capital formation summarizes the total amount of capital invested in office buildings, factories, stores, and the like. Other things being equal, the greater the capital investment in an economy, the more favorable its future growth prospects are likely to be. Viewed this way, FDI can be regarded as an important source of capital investment and a determinant of the future growth rate of an economy.

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In recent article, Choe (2003) investigates the causality between the economic growth and FDI, and between the economic growth and the gross domestic investment (GDI) with the data of 80 countries from 1971 to 1995. He fined a significant bi-direction Granger cause between economic growth and FDI, and just an unidirectional Granger cause between economic growth and GDI. These findings are valuable; however, do not clearly identified the roles of FDI and GDI in economic growth.

This study aims to find a new empirical approach to fill this gap and tries to answer the question whether the relationship between FDI and GDI is complementary or substitutive with Taiwanese data. Examining the behaviors of the FDI/GDP and the GDI/GDP ratios, depicted graphically in Figure no. 1, the right vertical axis measures the FDI/GDI ratio and the left vertical axis measures GDI/GDO ratio. We see that FDI/GDP ratio increased from 0.2% in 1981 to 0.5% in 2004; the ratio reduced to 0.4% in 2005 but jumped to more than 2% in 2006. As to the performance of the GDI/GDP ratio, it decreased from 20% in 1981 to 16% in 1986. In 2000 and 2001, the ratio dropped dramatically because of the worldwide recession. Although this ratio increased in 2003, it was just about 17% since the whole investment level was already reduced.

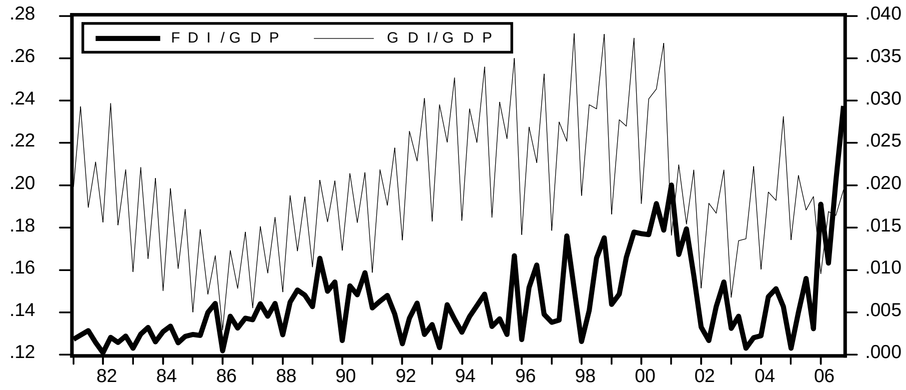

Figure no. 1: Behaviors of the FDI/GDP and the GDI/GDP ratios

It is common knowledge that whatever the resources are, an increase of investment has significant benefits to the economic growth. Contrarily, a decrease of investment has negative impacts not only in the short-run but also in the long-run economic performance of one country. Therefore, it is necessary to investigate the factors affecting the investment in Taiwan, especially the relationship between GDI and FDI. The findings from this analysis are hoped to be an important reference for the government in specifying investment related policies. Figure no. 1 shows that the FDI/GDP and the GDI/GDP ratios are negatively correlated before 1986, positively correlated from 1986 to 1990, negatively correlated again from 1990 to 1996, and positively correlated once more from 1996 to 2006. The changes of the relationship between these two ratios indicate nonlinearity between them, and this characteristic should be considered in the related empirical studies. To amply understand the relation between FDI and GDI, some macroeconomic variables are furthermore included in our empirical model for making our results more robust.

There are rarely previous studies that just examine the relationship between FDI and GDI. Most articles include other variables, in addition to FDI and GDI, to explore the relationship among them. Walid and Pauly (2002) utilize the Jorgenson theory to estimate the investment function of Canada. Using data from 1983 to 1995, the authors find that FDI and GDI are positively correlated, indicating the negative affect of a decrease of FDI on GDI. The authors also find that the Canadian outward foreign direct investment (FDIO) is positively correlated with GDI, showing the positive effect of an increase of FDIO on GDI. However, Feldstein (1995) explores U.S. investment and finds that an increase of U.S. FDIO would decrease U.S. GDI. In order to avoid the omitted variable problem with econometric approach, Desai et al. (2004) apply both macroeconomic and corporate panel data on the model that not only includes all variables used in Feldstein (1995) but also adds one new variable of expected economic growth. It is found that an increase of FDIO has a significant positive impact on GDI. This result is not consistent with the findings of Feldstein (1995).

Roedegebuure (2006) uses survey data across corporations during 1996 to 2000 to investigate the relation between FDIO and GDI. The author categorizes technology firms into three different levels- high, medium and low- according to the definition specified by OECD (Organization for Economic Cooperation and Development). The Kruskal Wallis test of non-parametric analysis is applied to examine whether there exists different characteristics among the firms. When Pearson is further utilized to analyze the relationship between FDIO increase and R&D expenses, it is found that this relation is positive. The stepwise regression results also suggest that internationalization helps the increases in domestic R&D expenses of high technology firms, conforming with expectation. As to the relation between FIDO and GDI, it is found a slight positive relation between them. The reason may be that most companies move the production sectors to overseas countries for reducing the production cost. This behavior may offset their positive relationship.

Klein and Rosengren (1994), Bayoumi and Lipworth (1998), and Kiyota and Urata (2004) fail to obtain the consistency in findings of the impact of the exchange rate on FDI. Froot and Stein (1991), Dewenter (1995), Choi and Jeon (2007) explore the influence of the exchange rate on FDIO and find different results. Choi and Jeon (2007) employ the dynamic time series analysis to inspect the impacts of financial variables on FDIO in four largest industrial countries. They find that FDIO is a non-stationary variable and has a long-run relationship with the real exchange rate, and that there is a causal effect of the exchange rate on direct investment in the short run.

Investigating the determinant affecting the FDI of Malaysia, Ang (2008) finds that real GDP has a significantly positive impact on FDI inflows, which is consistent with the prediction of the market size hypothesis. In addition, GDP growth rate has a small positive effect on inward FDI. These findings suggest that higher developments in the financial sector, infrastructure, and trade openness all help promote FDI; on the contrary, higher statutory corporate tax and real exchange rate appreciation discourage FDI inflows. The surprise is that higher macroeconomic uncertainty seems to help induce more FDI inflows.

The economic literature has yielded a large number of in-depth studies concerning the relation between national investment and saving, such as Dar et al. (1994), Jansen (1996), De Vita and Abbott (2002), Pelagidis and Mastroyiannis (2003), Corbin (2001), and Chakrabarti (2006). However, these researches mainly focus on the correlation between gross national saving (GNS) and GDI and their results are not consistent. Yet historically, relatively little has been known about the relationship between GNS and FDI.

The key issue we address in this paper is the impact of GNS on both GDI and FDI, particularly with variables used in the previous studies on FDI or GDI. It is known that there may be a number of factors affecting the relationship between them, including FDIO, GDP, GNS, and nominal exchange rate (EX), which are used as exogenous variables[1] in our context. Particularly, the asymmetric effect taken into consideration is the point of our study, which is quite different from the previous studies that almost make the assumption of symmetry. According to Razin et al., (1998); Kinoshita and Mody (1999) asymmetric information is an important factor contributing to preference for FDI (or GDI) compared with other sources of financing. This is more obvious to economies characterized by a general lack of transparency, low standards of business conduct, and inadequate protection of creditor and minority shareholder rights. As a result, Buiter et al. (1998) points out that the foreign strategic investor of companies in transition economies which rely primarily on FDI take almost the majority control over the firm.

Additionally, economic research provides various evidences about the impact of economy on investment. According to Desai et al. (2004), future economic development has crucial influence on investment. However, this discuss does not deeply explore the different impacts between economic booms and recessions on investments. Ang (2008) argues that the uncertainty of future economic development is one of the major factors affecting FDI. Nevertheless, the author models the uncertainty with the GARCH model in a linear estimation, which could not measure the asymmetric effect associated with different economic statuses. To both foreign and domestic investors, the expectation of future economic growth would have critical influence on their investment decisions. The boom expectation will enhance firms' future profits and may lead to an increase in both FDI and GDI. Contrarily, the depression expectation implies an decrease in future profits or even losses and may lead to a reduction of both FDI and GDI. While the two economic statuses, expansion and recession, might have a great impact on one country's FDI and GDI, there is not any empirical evidence exists to distinguish between them. Therefore, these two economic statuses are recognized as the resource of the asymmetric effect in this study.

In addition, Beaudry and Koop (1993) design the indicator of Current Depth of Recession (*CDR*), which measures the asymmetry of the business cycle. However, this *CDR* uses the exogenous standard to evaluate the business cycle status, so the results could not actually indicate the critical point of the transition of a business cycle status. In this paper, we would like to adjust this *CDR* indicator and use the adjusted CDR as a threshold variable in our threshold model. Since the threshold model endogenously determines the transition points, the estimation results would be more accurate.

The main question we address is whether the relationship between FDI and GDI is substitution or complement. Because the symmetric-linear model that is used by most previous studies might neglect the non-linearity caused by business cycle status, in addition to the use of four macroeconomic variables; FDIO, GDP, GNS, and EX., the nonlinear-asymmetric issue is also taken into consideration to find an accurate answer.

[1] The primary reason for us to add those variables is to avoid the so-called omitted variable problem.

The process of this empirical study includes five steps. First, we examine the correlations among FDI, GDI, and the four exogenous variables. Second, we plot the time series of FDI and GDI to observe whether the two variables are nonlinearly correlated. Third, we examine the existence of the long-run relationship between the two variables. Fourth, we inspect the existence of the short-run non-linearity between the two target variables (FDI and GDI) and the four exogenous variables. If both the non-linearity and the cointegration do exist, we then utilize the threshold vector error correction model (TVECM) to proceed the short-run dynamic analysis. Finally, we test the asymmetric causality to investigate the strong and weak exogenities among the variables.

Our findings within this process could be summarized as follows. First, we apply the Pearson correlation coefficient test and find that the four exogenous variables are significantly correlated with both FDI and GDI. Second, unit root test result shows that all the variables are I(1). Utilizing the Johansen cointegration test, we find that FDI and GDI are cointegrated in the long run. In addition, we employ the adjusted *CDR* as a threshold variable to divide the model into two regimes (the expansionary regime and the recession regime) and use the TVECM estimation to confirm the causality of all the variables in the short run. The estimation result suggests that in the expansionary period, FDI has a unidirectional negative impact on GDI and the two variables are characterized by the substitute; in the recession period, FDI has a positive impact on GDI and the two variables are complement. As to the impacts of the exogenous variables on FDI and GDI, in the expansionary period, only EX could positively affect FDI, which indicates that the depreciation of Taiwanese dollar (NTD) could attract FDI; in the recession period, FDIO and GNS have positive affects on GDI, GDP and EX have negative impacts on GDI, and FDIO has a positive impact on FDI. Analyzing the deviation from the equilibrium of the error correction for identifying the indirect effects of the exogenous variables on FDI and GDI, we find that in the expansionary period, all the exogenous variables could indirectly affect FDI, and in the recession period, all the exogenous variables could indirectly impact GDI. These results mean that FDI is affected by all the exogenous variables through the error correction in the expansionary period, contrarily, GDI is affected in the recession period.

The remainder of this paper is organized as follows. Section 1 details the research methodology, the data, the summary statistics and the empirical model. The empirical findings are discussed in Section 2, and Section 3 concludes this paper.

1. Research methodology

In this section, we present the variable description and examine the correlation among the variables as well as the nonlinear characteristic of FDI and GDI. When the nonlinearity of FDI and GDI are confirmed, we then utilize the asymmetric business cycle indicator as our threshold variable to construct the threshold model.

1.1 Data description and correlation analysis

The endogenous variables including FDI and GDI and the exogenous variables covering FDIO, GDP, GNS, and EX are reported in Table no. 1.

Table no. 1: Variable Description

Variable	Description	Unit
FDI	Foreign direct investment	Million NTD
FDIO	Outward foreign direct investment	Million NTD
GDI	Fixed capital formation	Million NTD
GDP	Gross domestic product	Million NTD
GNS	Gross national saving	Million NTD
EX	Nominal exchange rate (NTD/US $)	

Note: Except for the exchange rate, all other variables are in real terms. We take logarithms of all the variables before conducting all the tests.

The sample period spreads from the first quarter of 1981 to the fourth quarter of 2006 with 104 observations. All the data is obtained from the databank of Directorate-General of Budget, Accounting, and Statistics, Executive Yuan, R.O.C. (Taiwan). Except for the exchange rate, all other variables are in real terms. We take logarithms of all the variables before conducting all the tests. Figure no. 2 graphs the time series of variables.

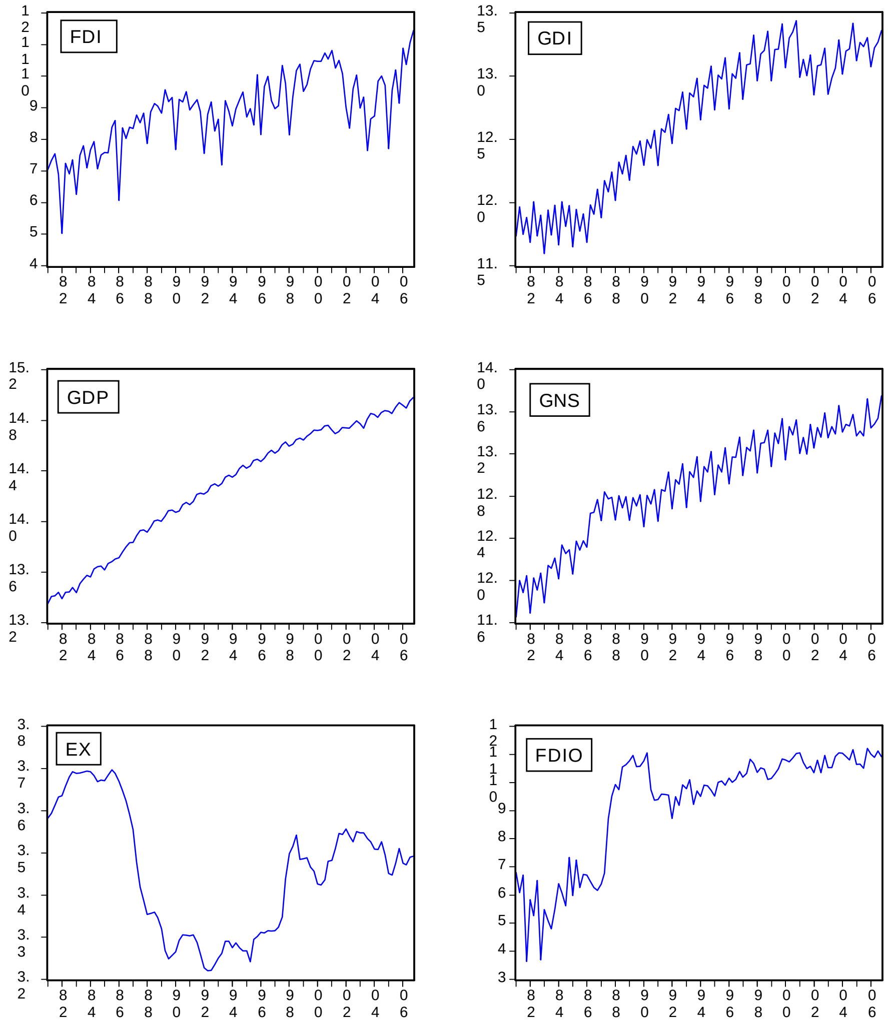

Figure no. 2: Time series of all variables

It is seen that except for EX, the values of the rest variables are increasing over time. FDI and FDIO have larger fluctuations; FDIO was more fluctuant before 1990 and less afterwards. It seems that GDI and GNS may have quarterly fluctuations. As to the behavior of EX, the Taiwanese dollar highly appreciated in the 1990s and depreciated after the 1997 Asian financial crisis.

To ascertain the impacts of the four exogenous variables on FDI and GDI, we first employ the Pearson correlation coefficient to conduct the pairwise correlation test and report the test results in Table no. 2.

Table no. 2: Pearson correlation coefficient test

Variable	GDI	GDP	GNS	FDIO	EX
FDI	0.78***	0.77***	0.79***	0.73***	-0.35***
GDI		0.95***	0.95***	0.84***	-0.42***

*Note: The null hypothesis of the test is that the corresponding correlation coefficient equals 0. *** indicates the 1% significance.*

The four exogenous variables significantly correlated with FDI and GDI, which indicates that the inclusion of these exogenous variables in the model may help to find the true relationship between FDI and GDI. The coefficients reported in Table 2 also point out that FDI and GDI are positively correlated with the exogenous variables, except for EX. This means that, without the consideration of any other information, the depreciation of NTD would reduce the investing incentive of both foreigners and the domestic firms. The results in Table 2 are viewed as a preliminary examination of the correlations among variables under symmetric condition, the more accurate correlation analysis with asymmetric consideration should be done through systematic tests.

1.2 The nonlinearity of variables

Before conducting the nonlinear estimation, we utilize the Scatter with Nearest Neighbor Fit and the Scatter with Kernel Fit methods to plot the fitted lines of FDI and GDI to examine the nonlinear characteristics of these two variables.[2] In the Scatter with Nearest Neighbor Fit method, the bandwidth span determines which observations should be included in the local regressions, and the span controls the smoothness of the local fit. The polynomial degree specifies the degree of polynomial to fit in each local regression. Symmetric neighbors force the local regression to include the same number of observations to the left and to the right of the point being evaluated. The Robustness iterations option carries out a form of weighted least squares where outlying observations are given relatively less weight in estimating the coefficients of the regression. The result of the Scatter with Nearest Neighbor Fit method is listed in Figure no. 3.

[2] The Scatter with Nearest Neighbor Fit method displays local polynomial regressions with bandwidth based on nearest neighbors. Briefly, for each data point in a sample, a locally weighted polynomial regression is fitted first. It is a local regression since the observations used are a subset of observations lying in a neighborhood of the point to fit the regression model; it is weighted so that observations further from the given data point are given less weight. This class of regressions includes the popular Lowess (also known as Lowess) techniques described by Cleveland (1993, 1994). Additional discussion of these techniques may be found in Fan and Gijbels (1996), and in Chambers et al. (1983). As to the Scatter with Kernel Fit method, it displays fits of local polynomial kernel regressions of the second series in the group Y on the first series in the group X. Both the nearest neighbor fit, described above, and the kernel fit are nonparametric regressions that fit local polynomials. The two methods differ in how they define "local" in the choice of bandwidth. The effective bandwidth in nearest neighbor regression varies, adapting to the observed distribution of the regressor. For the kernel fit, the bandwidth is fixed but the local observations are weighted according to a kernel function. Extensive discussion may be found in Simonoff (1996), Härdle (1991), Fan and Gijbels (1996).

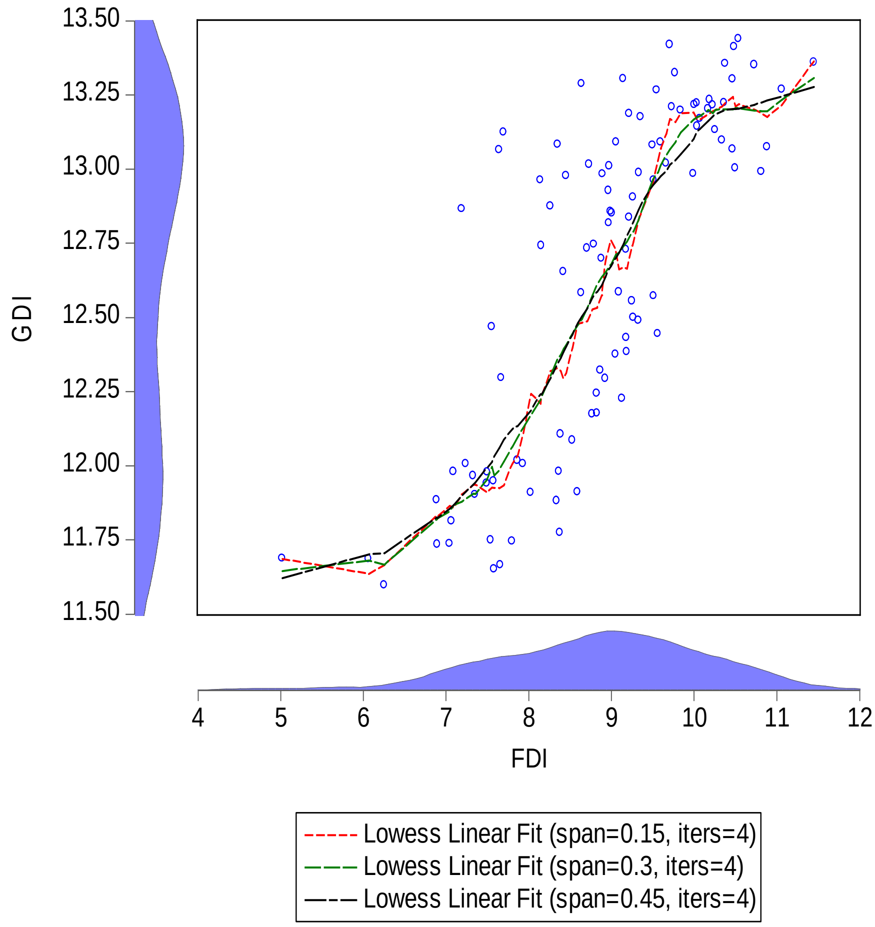

Figure no. 3: Scatter with Nearest Neighbor Fit of FDI and GDI

We use three bandwidth spans: 0.15, 0.30, and 0.45; the polynomial degree is 1 and the iteration number is 4, a speciation following Cleveland (1993). It is very apparent that FDI and GDI are nonlinearly correlated in the three bandwidth spans. Figure 4 shows the result of the Scatter with Kernel Fit method. In this method, the kernel is the function used to weight the observations in each local regression, and is specified as a Cosinus function.[3] In

[3] The Cosinus function is specified as $\frac{\pi}{4}\cos(\frac{\pi}{2}u)I(|u \leq 1|)$, where u is the argument of the kernel function and I is the indicator function that takes a value of one, if its argument is true, and zero otherwise.

Figure no. 4, we also employ three bandwidth (h): 0.48, 0.96, and 1.44. It is very obvious that the relationship between FDI and GDI is characterized with nonlinearity as well.

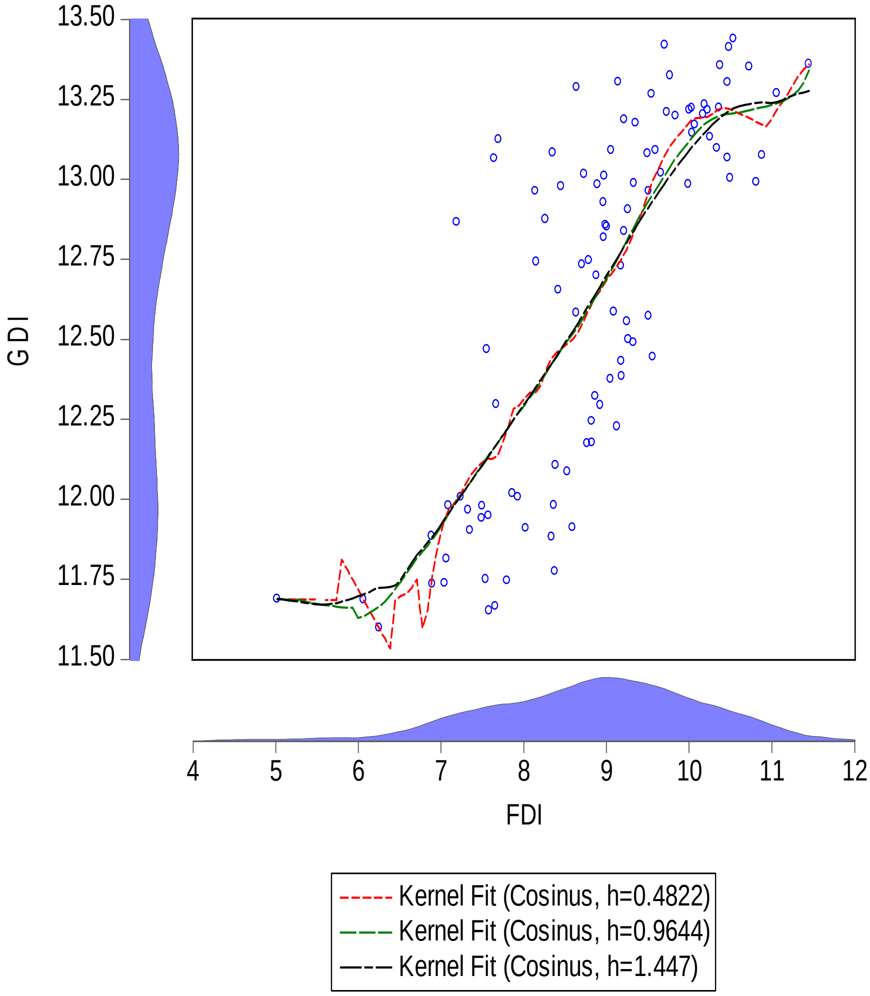

Figure no. 4: Scatter with Kernel Fit of FDI and GDI

1.3 The original CDR and adjusted CDR

CDR, the indicator of business cycle presented by Beaudry and Koop (1993), was originally employed to analyze the asymmetry of business cycles. This indicator could represent two economic states: *CDR* = 0 and *CDR* > 0. The former represents the expansionary period of an economy, and the later indicates the recessional period of the economy. The *CDR* equation is specified as follows:

$$CDR_t = max\{Y_{t-s}\}_{s\geq 0}^{t} - Y_t \tag{1}$$

where Y_t is the output level of period t; CDR_t is the output gap between the historical maximum level of output (between period t and period s, the previous period) and the output level at period t. Therefore, $CDR > 0$ indicates that the economic system breaks away the original trend of economic growth, displaying the recession of business cycle. Equivalently, $CDR = 0$ exhibits the expansion of business cycle.

Even if *CDR* could accurately capture the recession periods, it still needs to be modified for two reasons. First, *CDR* assigns 0 to the expansionary periods so it cannot be utilized into the threshold estimation. Second, since *CDR* exogenously determine the threshold values, it cannot be applied to cross country analysis or to a multivariate threshold model.

With regard to the above mentioned imperfections of the *CDR* indicator in equation (1), this study would like to revise it to better fit our purpose in the following estimations. The revised framework also creates the two regimes of both recession and expansion and has two benefits. First, the original business cycle values identified by the original *CDR* in equation (1) could be retained. Second, the expansionary periods that could not be detected by the original *CDR* can now be recovered by our new *CDR* indicator. We name our adjusted *CDR* as *ACDR* whose function form is stated in equation (2):

$$ACDR_t = \frac{CDR3_t}{STD_{CDR3}} = \frac{CDR3_t}{\sqrt{\sum (CDR3_t - \mu_{CDR3})^2 / N-1}}, \tag{2}$$

where $CDR3_t = -(max\{Y_{t-s}\}_{s>0}^{t} - Y_t) = Y_t - max\{Y_{t-s}\}$;[4] STD_{CDR3} indicates the standard deviation of *CDR*3; μ_{CDR3} is the mean of *CDR*3; N is the number of observations.

1.4 The Threshold model

Tong (1978) and Tong and Lim (1980) develop the threshold autoregressive (TAR) model based on an optimal threshold value that divides the dynamic status of one economic indicator into two regimes. Taking into account the cointegration relationship between FDI and GDI, we create the TVECM to carry out the estimation. To adjust the short-run disequilibrium, TVECM, relative to TVAR, has only one discrepancy in the error correction term (ECT). The specification of the TVECM is as follows:

[4] In order to avoid the confusions caused by the opposite signs between the adjusted *CDR* values and business cycle states when explaining the empirical results, we specify *CDR*3 as the adjusted *CDR* multiplied by -1. In other words, the positive and negative values of *CDR*3 correspond to the expansion period (positive) and the recession period (negative) of business cycles, respectively.

$$\Delta GDI_t = \begin{cases} \left.\begin{aligned} &\alpha_{10} + \sum_{i=1}^{p} \alpha_{11,i} GDI_{t-i} + \sum_{i=1}^{p} \alpha_{12,i} \Delta FDI_{t-i} \\ &+ \sum_{i=1}^{p} \alpha_{13,i} \Delta FDIO_{t-i} + \sum_{i=1}^{p} \alpha_{14,i} \Delta GDP_{t-i} \\ &+ \sum_{i=1}^{p} \alpha_{15,i} \Delta GNS_{t-i} + \sum_{i=1}^{p} \alpha_{16,i} \Delta EX_{t-i} + \omega_{11} ECT_{t-1} + \varepsilon_{11,t} \end{aligned}\right\} ACDR_{t-d} > \gamma \\ \left.\begin{aligned} &\alpha_{20} + \sum_{i=1}^{p} \alpha_{21,i} GDI_{t-i} + \sum_{i=1}^{p} \alpha_{22,i} \Delta FDI_{t-i} \\ &+ \sum_{i=1}^{p} \alpha_{23,i} \Delta FDIO_{t-i} + \sum_{i=1}^{p} \alpha_{24,i} \Delta GDP_{t-i} \\ &+ \sum_{i=1}^{p} \alpha_{25,i} \Delta GNS_{t-i} + \sum_{i=1}^{p} \alpha_{26,i} \Delta EX_{t-i} + \omega_{12} ECT_{t-1} + \varepsilon_{12,t} \end{aligned}\right\} ACDR_{t-d} \le \gamma \end{cases} \quad (3)$$

$$\Delta FDI_t = \begin{cases} \left.\begin{aligned} &\beta_{10} + \sum_{i=1}^{p} \beta_{11,i} GDI_{t-i} + \sum_{i=1}^{p} \beta_{12,i} \Delta FDI_{t-i} \\ &+ \sum_{i=1}^{p} \beta_{13,i} \Delta FDIO_{t-i} + \sum_{i=1}^{p} \beta_{14,i} \Delta GDP_{t-i} \\ &+ \sum_{i=1}^{p} \beta_{15,i} \Delta GNS_{t-i} + \sum_{i=1}^{p} \beta_{16,i} \Delta EX_{t-i} + \omega_{21} ECT_{t-1} + \varepsilon_{21,t} \end{aligned}\right\} ACDR_{t-d} > \gamma \\ \left.\begin{aligned} &\beta_{20} + \sum_{i=1}^{p} \beta_{21,i} GDI_{t-i} + \sum_{i=1}^{p} \beta_{22,i} \Delta FDI_{t-i} \\ &+ \sum_{i=1}^{p} \beta_{23,i} \Delta FDIO_{t-i} + \sum_{i=1}^{p} \beta_{24,i} \Delta GDP_{t-i} \\ &+ \sum_{i=1}^{p} \beta_{25,i} \Delta GNS_{t-i} + \sum_{i=1}^{p} \beta_{26,i} \Delta EX_{t-i} + \omega_{22} ECT_{t-1} + \varepsilon_{22,t} \end{aligned}\right\} ACDR_{t-d} \le \gamma \end{cases} \quad (4)$$

where Δ indicates the first difference; α and β are the parameters; $\varepsilon_{1,t}$ and $\varepsilon_{2,t}$ are the error terms; $ACDR_{t-d} > \gamma$ indicating an expansion, while $ACDR_{t-d} \le \gamma$ indicating a recession; ω_{11}, ω_{12}, ω_{21} and ω_{22} are the adjusting coefficients of ECT_{t-1}; ECT_{t-1} is the error correction term of period $t-1$ in the long-run equilibrium:

$$ECT_{t-1} = GDI_{t-1} - \theta\, FDI_{t-1}, \quad (5)$$

where θ is the parameter of the cointegration equation.

In order to confirm the causality of the short-run dynamic effect, we employ the *Wald* coefficient test to determine the causality between the variables (strong exogeneity). In addition, we could verify the weak exogeneity through the significance of the adjusting coefficients (ω_{11}, ω_{12}, ω_{21}, and ω_{22}) of the error correction term under different regimes.

2. The Empirical Results

We start our empirical study with the unit root test in order to clear up the stationarity of all the variables. If the variables are I(1), then we employ the Johansen (1995) cointegration test, with the consideration of the impact of the exogenous variables (FDIO, GDP, GNS, and EX), to examine the cointegration between FDI and GDI. If FDI and GDI are cointegrated, a linearity test is applied to confirm that the empirical model could be used in the nonlinear framework. That is, if the null hypothesis of linearity is rejected, we then estimate a nonlinear TVECM to analyze the short-run disequilibrium and conduct the causality test.

We employ three forms of unit root tests: Augmented Dickey-Fuller test (1979, ADF), Elliott et al. test (1996, DF-GLS), and Ng and Perron test (2001, NP-MZ_a). Since the time series in Figure 2 just exhibit the apparent time trends, it is necessary to include both the constant term and the time trend in the regression equations of the unit root tests. In addition, the optimal lag length of 12 is selected according to the Akaike information criterion (AIC). The test results reported in Table no. 3 show that all the variables, under the 10% significant level, are I(1).

Table no. 3: Unit Root Tests

		EX	FDI	FDIO	GDI	GDP	GNS
ADF	***Level***	-1.399 [1]	-2.516 [4]	-2.136 [8]	-1.219 [8]	-1.284 [8]	-2.470 [8]
	First difference	-2.995***[0]	-16.08***[0]	-4.377***[7]	-3.226*[7]	-4.219***[7]	-4.394***[7]
DF-GLS	Level	-1.362 [1]	-2.521 [3]	-1.790 [1]	-1.496 [8]	-0.947 [8]	-0.533 [8]
	First difference	-5.816***[0]	-9.688***[2]	-5.763***[1]	-2.840*[7]	-2.888*[7]	-4.844***[2]
NP-MZ_a	Level	-3.988 [1]	-9.398 [3]	-6.058 [1]	-9.504 [2]	-3.403 [1]	-1.765 [8]
	First difference	-39.31***[0]	-133.3***[3]	-20.16** [1]	-36.34***[2]	-125.4***[1]	-268.4***[2]

Note: The maximum lagged period is 12. The numbers in square brackets are the appropriate lag lengths selected by the Akaike information criterion in the ADF: Augmented Dickey-Fuller test, DF-GLS: Dickey-Fuller generalized least squares test, NP-MZa: Ng and Perron MZa test. The critical values for 1% significant level of ADF, DF-GLS, and NP-MZ_a tests are -4.057, -3.457, and -3.154, respectively; the critical values for

*5% significant level of the three tests in the order are -3.577, -3.028, and -2.738, respectively; the critical values for 10% significant level of the three tests in the order are -23.80, -17.3, and -14.20, respectively. Critical values of the ADF and DF-GLS tests are from MacKinnon (1991). Critical values of the NP-MZa test are from Ng and Perron (2001).The numbers in the parentheses [.] of ADF test are the lag lengths selected by applying AIC. ***, **, and * denote the significance at 1%, 5% and 10% level, respectively.*

Table no. 4 lists the results of optimal lag lengths for the VAR model and we select the maximum of 12 periods for testing. In order to have alternative selections for the optimal lag, we employ three criteria, including the Final prediction error (FPE) criterion, AIC, and the Schwarz information criterion (SC). It is found that the optimal lag length is 8. Therefore, this study adopts the lag length of 8 to test for cointegration as well as to estimate the model.

Table no. 4: Lag Selection for VAR Model

Lag	FPE	AIC	SC
0	NA	0.002	0.18
1	27.13	0.002	-0.09
2	7.38	0.002	-0.11
3	42.79	0.002	-0.61
4	24.05	0.002	-0.87
5	5.09	0.002	-0.85
6	8.20	0.002	-0.89
7	2.31	0.002	-0.84
8	**27.31****	**0.001****	**-1.19****
9	3.15	0.002	-1.16
10	2.33	0.002	-1.11
11	2.53	0.002	-1.07
12	6.85	0.002	-1.10

*Note: FPE expresses the final prediction error, AIC is the Akaike information criterion, SC denotes the Schwarz information criterion, ** denotes the 5% significant level.*

The results of Johansen cointegration test are reported in Table no. 5.

Table no. 5: Cointegration Test

VAR lags = 8 Null Hypothesis	Alternative Hypothesis	Statistics	5% Critical Value
λ_{trace} tests			
$\tau = 0$	$\tau > 0$	14.99**	12.32
$\tau \leq 1$	$\tau > 1$	1.34	4.13
$\lambda_{\max}$ tests			
$\tau = 0$	$\tau = 1$	13.65**	11.22
$\tau = 1$	$\tau = 2$	1.34	4.13

*Note: The lag length is determined by the sequential AIC test. **denotes the 5% significant level.*

We consider the level data to have no deterministic trend and the co-integrating equations to have no intercept which is clearly stated in Johansen (1995). The null hypothesis is in the following form:[5]

$$H^*(\theta): \Pi y_{t-1} + Bx_t = \alpha\beta' y_{t-1}, \tag{6}$$

where y_t denotes the endogenous variable; x_t denotes the exogenous variable; θ is the cointegration vector; $\Pi = \alpha\beta'$ is the co-integration vectors.

We use two statistics for the test, the *Trace*-statistic (λ_{trace}) and the *Maximum-eigenvalue* statistic ($\lambda_{\max}$):

$$\lambda_{trace}(\tau) = -T\sum_{i=\tau+1}^{k}\log(1-\hat{\lambda}_i), \tag{7}$$

$$\lambda_{\max}(\tau, \tau+1) = -T\log(1-\hat{\lambda}_{\tau+1}), \tag{8}$$

where $\hat{\lambda}_i$ is the estimated value of the characteristic root; *viz.* eigenvalue, obtained from the estimated Π matrix *T,* is the number of usable observations. When the appropriate values of τ are clear, these statistics are simply referred to as λ_{trace} and $\lambda_{\max}$.

With the 5% significant level, the results of the cointegration test shown in Table no. 5 provide evidence that FDI and GDI are cointegrated. Based on this long-run relationship, the error correction term is specified as follows:

[5] We consider all the five models with deterministic trends proposed by Johansen (1995), but only the model of long-run relationship conforms the economic relationship and statistic results.

$$ECT_t = GDI_t - \underset{(0.000)}{1.352} FDI_t \tag{9}$$

Equation (9) displays the stable long-run relationship between FDI and GDI, p-value in the parenthesis show the positive impact of FDI on GDI at 1 % significant level. This result implies that 1 % increase in FDI boosts a raise 1.352 % of GDI, proving the complement between FDI and GDI in the long run. Simply put, FDI inflow helps the increase in GDI. This finding could be interpreted that the more FDI that government policies attract, the more GDI increases, which in turn, could fuel economic growth of the country.

Because of the appearance of cointegration, when building the vector error correction model to test for causality between FDI and GDI, we add the error correction term in the model for analyzing the adjustment of short-run disequilibrium and further confirming the dynamic relation between these two variables. Besides, in order to realize the existence of nonlinearity, the linear test is applied to each mono-regime model to verify the optimal framework adopted. During the process of linear test, we follow the testing mode of Tsay (1998) whose null hypothesis is the linear TVECM and alternative hypothesis is the nonlinear VECM.

Table no. 6 shows the results of linear test represented by the p-values of statistic Chi-squared test. When the threshold variable delays 8 periods (d=8), the testing result significantly reject the linear hypothesis, confirming the nonlinearity of model. In other words, we could employ $ACDR_{t\text{-}8}$ to separate the short-run dynamic relationship between FDI and GDI into two regimes.

Table no. 6: Linearity Test

p / d	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1	0.27	0.35	0.04	0.11	0.28	0.28	0.51	0.65
2		0.00	0.01	0.07	0.08	0.11	0.08	0.09
3			0.01	0.41	0.25	0.42	0.42	0.40
4				0.31	0.23	0.09	0.09	0.09
5					0.53	0.58	0.58	0.78
6						0.31	0.40	0.69
7							0.23	0.49
8								**0.00**

Note: The above values are the p-values of Chi-square test for linearity.

In order to accurately estimate reveal the relationship among the variables, we follow the simplicity principle that when estimating equations (3) and (4), we delete the variables whose coefficients are insignificant. The estimation results of the TVECM model are listed in equations (10) and (11). Numbers in the squared brackets are the summation of the coefficients, and ** and *** stand for the 5% and 1% significant levels. The threshold value equals 0.08, which means that $ACDR_{t\text{-}8} > 0.08$ corresponding to the expansionary regime and 60 observations belonging to this period. When $ACDR_{t\text{-}8} \leq 0.08$, it indicates the recession regime, and 35 observations are in this period. It is obviously seen that , the expansionary regime is longer than recession regime in Taiwan during the sample period.

To ascertain the appropriateness of the model, it is necessary to verify if the estimated residuals are white noises. The ARCH(1) test shows that the variances of the residuals do not exhibit first-order heteroskedasticity. LM(12) test shows that there is not exist 12-period auto-correlation of the residuals. The cross-correlation shown in Figure no. 5 also confirms that the residuals do not have cross correlations.

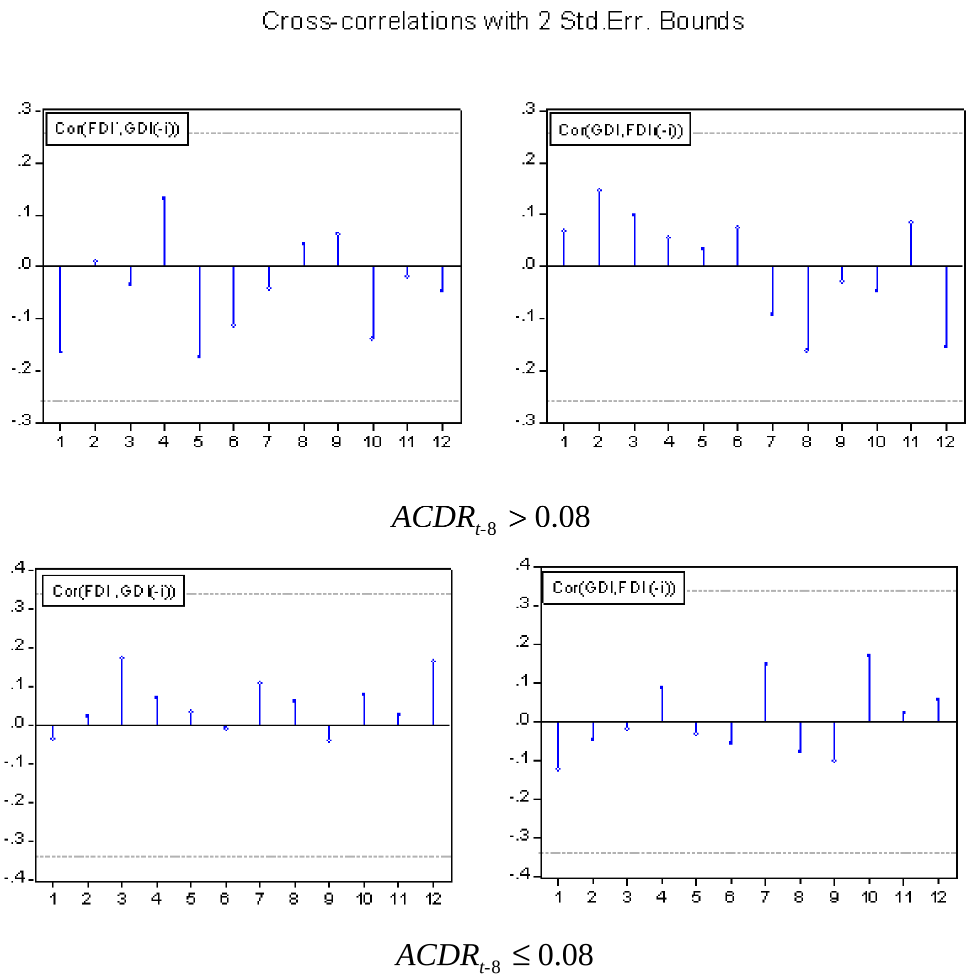

Figure no. 5: Cross correlation of GDI and FDI within regimes 1 and 2

The Granger causality test is employed to analyze the short-run relationship between FDI and GDI and the impacts of the exogenous variables on the two endogenous variables. The signs of the numbers in the squared brackets of equations (10) and (11) are used to determine the directions of the relationship and of the impacts.

$$
\Delta GDI_t = \begin{cases}
\left.\begin{array}{l}
\sum_{i=1}^{p}\alpha_{11,i}GDI_{t-i} + \sum_{i=1}^{8}\alpha_{12,i}\Delta FDI_{t-i} + \sum_{i=1}^{3}\alpha_{13,i}\Delta FDIO_{t-i} + \sum_{i=1,3,4}\alpha_{14,i}\Delta GDP_{t-i} \\
\quad [0.28] \qquad\quad [-0.07]^{***} \qquad\qquad [0.04] \qquad\qquad\quad [1.58] \\
+ \sum_{i=1,2,4}\alpha_{15,i}\Delta GNS_{t-i} + \sum_{i=1}^{3}\alpha_{16,i}\Delta EX_{t-i} + \omega_{11}ECT_{t-1} \\
\qquad [0.11] \qquad\qquad [0.10] \qquad\quad [-0.01]
\end{array}\right\} & ACDR_{t-8} > 0.08 \\
\left.\begin{array}{l}
\sum_{i=1}^{8}\alpha_{21,i}GDI_{t-i} + \sum_{i=1}^{8}\alpha_{22,i}\Delta FDI_{t-i} + \sum_{i=1}^{3}\alpha_{23,i}\Delta FDIO_{t-i} + \sum_{i=1,3,4}\alpha_{24,i}\Delta GDP_{t-i} \\
\quad [1.09] \qquad\quad [0.01]^{***} \qquad\quad [0.13]^{***} \qquad\quad [-4.60]^{***} \\
+ \sum_{i=1,2,4}^{p}\alpha_{25,i}\Delta GNS_{t-i} + \sum_{i=1}^{3}\alpha_{26,i}\Delta EX_{t-i} + \omega_{12}ECT_{t-1} \\
\qquad [1.86]^{***} \qquad\quad [-0.47] \qquad\quad [0.05]^{***}
\end{array}\right\} & ACDR_{t-8} \le 0.08
\end{cases}
$$

ARCH(1) test = 7.00-E05 (0.99)

LM(12) test = 8.06 (0.78)

(10)

ARCH(1) test = 0.25 (0.62)

LM(12) test = 7.66 (0.81)

$$
\Delta FDI_t = \begin{cases}
\left.\begin{array}{l}
\sum_{i=1}^{8}\beta_{11,i}GDI_{t-i} + \sum_{i=1}^{p}\beta_{12,i}\Delta FDI_{t-i} + \sum_{i=1}^{3}\beta_{13,i}\Delta FDIO_{t-i} + \sum_{i=1,3,4}\beta_{14,i}\Delta GDP_{t-i} \\
\quad [0.70] \qquad\quad [-0.28]^{***} \qquad\qquad [0.22] \qquad\qquad\quad [18.5] \\
+ \sum_{i=1,2,4}^{p}\beta_{15,i}\Delta GNS_{t-i} + \sum_{i=1}^{3}\beta_{16,i}\Delta EX_{t-i} + \omega_{21}ECT_{t-1} \\
\qquad [-1.83] \qquad\quad [8.10]^{**} \qquad\quad [-0.29]^{***}
\end{array}\right\} & ACDR_{t-8} > 0.08 \\
\left.\begin{array}{l}
\sum_{i=1}^{8}\beta_{21,i}GDI_{t-i} + \sum_{i=1}^{p}\beta_{22,i}\Delta FDI_{t-i} + \sum_{i=1}^{3}\beta_{23,i}\Delta FDIO_{t-i} + \sum_{i=1,3,4}\beta_{24,i}\Delta GDP_{t-i} \\
\quad [5.52] \qquad\quad [-1.036]^{***} \qquad\quad [0.54]^{**} \qquad\qquad [27.4] \\
+ \sum_{i=1,2,4}\beta_{25,i}\Delta GNS_{t-i} + \sum_{i=1}^{3}\beta_{26,i}\Delta EX_{t-i} + \omega_{22}ECT_{t-1} \\
\qquad [-11.5] \qquad\quad [16.4] \qquad\quad [-0.24]
\end{array}\right\} & ACDR_{t-8} \le 0.08
\end{cases}
$$

ARCH(1) test = 0.65 (0.42)

LM(12) test = 7.22 (0.84)

(11)

ARCH(1) test = 0.54 (0.46)

LM(12) test = 1.90 (1.00)

Table no. 7 exhibits the causal test results within the two regimes. The first column of the table lists the dependent variables; the second column lists the causality; the third and the fourth columns list the null hypotheses, the sums of the coefficients, the values of the Chi-square statistics, and the p values corresponding to the expansionary regime; the fifth and sixth columns show the same entities as those of the previous two columns and correspond to the recession regime.

Table no. 7: Causality Test

Dependent variable	**Causality direction**	**Expansion ($ACDR_{t\text{-}8} > 0.08$)**		**Recession ($ACDR_{t\text{-}8} \leq 0.08$)**	
		Null hypothesis and sums of coefficients	**Chi-square test**	**Null hypothesis and sums of coefficients**	**Chi-square test**
ΔGL	$\Delta FDI \times\!\!\rightarrow \Delta GDI$	$H_0 : \alpha_{12,1} = \ldots = \alpha_{12,8} = 0$ $\sum_{i=1}^{8} \hat{\alpha}_{1,2i}$ **=-0.07**	**18.18*** (0.02)**	$H_0 : \alpha_{22,1} = \ldots = \alpha_{22,8} =$ $\sum_{i=1}^{8} \hat{\alpha}_{2,2i}$ **=0.01**	**67.55*** (0.00)**
	$\Delta FDIO \times\!\!\rightarrow \Delta GDI$	$H_0 : \alpha_{13,1} = \alpha_{13,2} = \alpha_{13,3}$ $\sum_{i=1}^{3} \hat{\alpha}_{1,3i}$ =0.04	3.88 (0.28)	$H_0 : \alpha_{23,1} = \alpha_{23,2} = \alpha$ $\sum_{i=1}^{3} \hat{\alpha}_{2,3i}$ **=0.13**	**34.77*** (0.00)**
	$\Delta GDP \times\!\!\rightarrow \Delta GDI$	$H_0 : \alpha_{14,1} = \alpha_{14,3} = \alpha_{14,4}$ $\sum_{i=1,3,4} \hat{\alpha}_{1,4i}$ =1.58	5.49 (0.14)	$H_0 : \alpha_{24,1} = \alpha_{24,3} = \alpha$ $\sum_{i=1,3,4} \hat{\alpha}_{2,4i}$ **=-4.60**	**64.93*** (0.00)**
	$\Delta GNS \times\!\!\rightarrow \Delta GDI$	$H_0 : \alpha_{15,1} = \alpha_{15,2} = \alpha_{15,4}$ $\sum_{i=1,2,4} \hat{\alpha}_{1,5i}$ =0.11	3.34 (0.34)	$H_0 : \alpha_{25,1} = \alpha_{25,2} = \alpha$ $\sum_{i=1,2,4} \hat{\alpha}_{2,5i}$ **=1.86**	**66.97*** (0.00)**
	$\Delta EX \times\!\!\rightarrow \Delta GDI$	$H_0 : \alpha_{16,1} = \alpha_{16,2} = \alpha_{16,3}$ $\sum_{i=1}^{3} \hat{\alpha}_{1,6i}$ =0.10	2.78 (0.43)	$H_0 : \alpha_{26,1} = \alpha_{26,2} = \alpha$ $\sum_{i=1}^{3} \hat{\alpha}_{2,6i}$ =-0.47	2.55 (0.47)
	$ECT \times\!\!\rightarrow \Delta GDI$	$H_0 : \omega_{11} = 0$ $\hat{\omega}_{11} =$ -0.01	-1.52 (0.13)	$H_0 : \omega_{12} = 0$ $\hat{\omega}_{12} =$ **0.05**	**4.554*** (0.00)**

ΔFD	ΔGDI ×→ ΔFDI	$H_0:\beta_{12,1}=...=\beta_{12,8}=$ $\sum_{i=1}^{8}\hat{\beta}_{1,1i}=0.70$	10.66 (0.22)	$H_0:\beta_{22,1}=...=\beta_{22,8}$ $\sum_{i=1}^{8}\hat{\beta}_{2,1i}=5.52$	8.67 (0.37)
	$\Delta FDIO$ ×→ ΔFDI	$H_0:\beta_{13,1}=\beta_{13,2}=\beta_{13,3}$ $\sum_{i=1}^{3}\hat{\beta}_{1,3i}=0.22$	1.79 (0.62)	$H_0:\beta_{23,1}=\beta_{23,2}=\beta$ $\sum_{i=1}^{3}\hat{\beta}_{2,3i}=\mathbf{0.54}$	**7.97** (0.05)**
	ΔGDP ×→ ΔFDI	$H_0:\beta_{14,1}=\beta_{14,3}=\beta_{14,4}$ $\sum_{i=1,3,4}\hat{\beta}_{1,4i}=18.50$	4.52 (0.21)	$H_0:\beta_{24,1}=\beta_{24,3}=\beta$ $\sum_{i=1,3,4}\hat{\beta}_{2,4i}=27.40$	2.25 (0.52)
	ΔGNS ×→ ΔFDI	$H_0:\beta_{15,1}=\beta_{15,2}=\beta_{15,4}$ $\sum_{i=1,2,4}\hat{\beta}_{1,5i}=-1.83$	0.61 (0.89)	$H_0:\beta_{25,1}=\beta_{25,2}=\beta$ $\sum_{i=1,2,4}\hat{\beta}_{2,5i}=-11.53$	1.50 (0.68)
	ΔEX ×→ ΔFDI	$H_0:\beta_{16,1}=\beta_{16,2}=\beta_{16,3}$ $\sum_{i=1}^{3}\hat{\beta}_{1,6i}=\mathbf{8.10}$	**7.63** (0.05)**	$H_0:\beta_{26,1}=\beta_{26,2}=\beta$ $\sum_{i=1}^{3}\hat{\beta}_{2,6i}=16.47$	3.65 (0.30)
	ECT×→ ΔFDI	$H_0:\omega_{21}=0$ $\hat{\omega}_{21}=\mathbf{-0.29}$	**-2.61*** (0.01)**	$H_0:\omega_{22}=0$ $\hat{\omega}_{22}=-0.24$	-0.500 (0.63)

*Note: The optimal threshold value (γ) is 0.082; the lag length of TVECM (p) is 8; the optimal lag of the threshold variable (d) is 8. The notation **A** ×→**B** presents the null hypothesis that the changes of (lagged) **A** cannot explain (current) **B**. The values in the parentheses "(.)" are the p-values of the Chi-square statistics of the join test. *** and ** denote the 1% and 5% significant levels, respectively*

In order to clearly analyze the test results in Table no. 7, we separate the analysis into two parts, one is the direct effect (the strong exogenity), and another is the indirect effect (weak exogenity) in each economic regime. Within expansion period ($ACDR_{t\text{-}8} > 0.08$), the direct effect of FDI on GDI is unidirectional and negative, indicating the substitute relationship between them, in other words, foreign investors expect to gain future profits and increase investments in Taiwan. However, this behavior would crowd out domestic investments and outstand the keen competition between foreign and domestic investors. All the four exogenous variables do not have either direct or indirect impacts on GDI, except for EX that is found to have positive effect on FDI. This positive effect evidences that a depreciation of NTD could attract FDI. Additionally, the significant ECT coefficient ($\hat{\omega}_{21}$) reveals the indirect affection of exogenous variables on FDI through ECT. Simply put, although most exogenous variables could not impact FDI in the short run, they could affect FDI through the short-run deviation adjustment toward the equilibrium during expansion.

Oppositely, within recession period ($ACDR_{t\text{-}8} \leq 0.08$), the direct effect of FDI on GDI is positive, proving the complement relationship between them. This means that the success in attracting FDI of government through economic or financial policies will enhance GDI and *vice versa* . The impact of the four exogenous variables are summarized as follows: the positive impact of FDIO and GNX on GDI presents a fall of domestic investment along with a reductions in outward investments and national saving; The negative impact of GDP and EX on GDI explains that when GDP goes down, the government may adopt stimulus or encouraging policies to enhance investment motivations, which in turn, increases GDI. Whereas, the depreciations of NTD is found to discourage GDI, and the appreciations of NTD helps enhance GDI. There is only one exogenous variable, FDIO, has positive effect on FDI , revealing the cut in both Taiwan's outward and inward investment. The significant ECT coefficient ($\hat{\omega}_{12}$) discloses the indirect affect of all the exogenous variables on GDI through ECT, in other words, all the exogenous variables affect GDI through the short run deviation adjustment toward the equilibrium during recession.

Based on the empirical results in this paper, it is shown that most exogenous variables, in the expansion period, could not directly affect FDI but indirectly influence FDI through the short-run adjustment toward the equilibrium, however, they, in the recession period, merely influence GDI through the short-run adjustment toward the equilibrium. In other words, the asymmetry of business cycles in the short run might cause the delay impacts of the exogenous variables on FDI or GDI. This finding suggests policy-makers that it is a crucial to ponder on the short-run adjustment as well as the long-run uncomplementary relationship between FDI and GDI before approving the contracted policies in the booms or the expansive policies in the recession.

Our findings propose a complex relation among FDI, GDI and macroeconomic variables. First, we find evidence consistent with Walid and Pauly's (2002) findings of the complementary relation between FDI and GDI merely in the long-run during recession. Second, Feldstein (1995) find that an increase of FDIO would reduce GDI, while Walid and Pauly (2002) and Desai et al. (2004) obtain a completely opposite result. In this paper, we also find that FDIO has a positive impact on GDI, but this effect could only be hold in the long-run during recession. Third, although we could not find the significant result consistent with Ang (2008) on the positive affect of GDP on FDI, we found the evidence consistent with him on the positive affect of EX on FDI. These inconsistent results might be resulted by the sample difference and the consideration of business cycle asymmetry, which we believe are the primary factors contributing to the differences of the empirical findings.

About the current financial crisis, the US subprime mortgage crisis has dramatically disturbed the world financial markets. The losses caused by the subprime mortgage crisis are increasing gradually, impelling the crisis to develop into the credit crisis among the banks and making the world financial market turbulent. This crisis generates the capital inflow into bond market, the dramatic fall of most stock markets, and the rapid increase of interest rate. Especially, because of the rapid increase of interest rate, there is a lot of rating agencies downgrade several issuers of commercial paper, causing the disruption in the asset-backed commercial paper markets, raising the risk of borrowers; hence, bank solvency became important. Therefore, the short term need, in not only US but also Taiwan, is how to enhance the solvency of Banks. FED announced in December 2007 that it and European Central bank, Bank of England, Bank of Canada, Swiss National *Bank*,

Bank of Japan, Sweden`s central Bank mutually take comprehensive measures to reach their purpose. Taiwan synchronously adopts the like policies; such as providing banks with the low cost capital with the temporary Term Auction Facility and lowered discount rate. These policies help to slow down the pressure on the increasing shortage of capital. However, according to our empirical result, FDI and GDI are substitute in the short run during expansion and complementary during recession, and the business-cycle asymmetric has a great impact on FDI inflows through numerous channels during boom and on GDI during recession.

Conclusions

This study uses the TVECM to examine the causality between FDI and GDI in Taiwan. We employ the *ACDR* as the threshold variable whose values are endogenously determined by the model to avoid the shortcomings of the traditionally *CDR* that subjectively (exogenously) select the threshold values. The advantage of doing this is to enhance the estimation efficiency. Unlike previous studies that are constrained by the linear estimation, this study takes into account the possibility that the relationship between FDI and GDI could be affected by the business cycle asymmetry. Under this consideration, we have two major empirical findings. First, there is a stable long-run relationship between FDI and GDI, and the two variables are complementary. Second, FDI and GDI are substitute in the short run during expansion and complementary during recession. Moreover, through the adjusting process toward the equilibrium, all the exogenous variables could indirectly impact FDI during expansion and indirectly affect GDI during recession. This implies that the economic information has an great impact on FDI inflows through numerous channels during boom, and on GDI during recession.

This study, compared to the related literatures, has the following innovations and contributions. With regard to the research motivation, this is the first paper using the nonlinear model to explore the relationship between FDI and GDI in Taiwan. As to the methodology, our model differs from those used by previous studies, such as the linear VAR and VECM which just focus on the symmetric relation between variables and overlook the asymmetric effect. For new discoveries, we find that the status of the business cycle, recession or expansion, has a great impact on the relationship between FDI and GDI. Using Taiwan's data to carry out the empirical study, this paper provides reasonable and logical explanations for findings that are new compared to those of the previous literature. On the academic perspective, we employ the methodology and the model that have never been used before in this field and contribute new discoveries to the existing literature.

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